3D Electromagnetic Plasma Particle Simulations on a MIMI) Parallel Computer

J. Wang, P.C. Liewer, and 1'. Lyster
Jet l'repulsion laboratory, California Institute of Technology
V.K. Decyk
{University of California, Los Angeles

Computer particle simulation has become a standard method in space and laboratory p] asma physics research. However, the scope of the physics that can be resolved in a simulation study critically depends on the computational power, which restricts the spatial sc.ale, time scale, and number of particles that can be used in a simulation. Massively parallel computers have provided computational possibilities that were previously not conceivable.

A three-dimensional electromagnetic plasma particle-in-cell code has been developed 011 the Intel Touchstone Delta MIMD parallel computer. This code simulates plasma effects by evolving in time the trajectories of charged particles in their self-collsistmlt electromagnetic field. Each particle is followed by integrating the Lorentz equation, and the electromagnetic field is updated locally using a rigorous charge-conservation finite-difference leap frog method[1]. This code is based on the General Cone.urrcmt PIC algorithm which uses a domain decomposition to divide the computation among the processors[2]. Particles must be exchanged between processors as they move between processor domains. The efficiences for 1-, 2-, and 3-dimensional partitions of the three dimensional domain are compared, and the algorithm is found to be very efficient even when a large fraction of the particles must be exchanged at every time step.

This parallel PIC code will be used to perform large scale simulations (up to more than 100 million particles) of a variety of plasma physics problems. Results of plasma wave radiation by a moving current source in a magnetized plasma will be discussed.

1. J. Villasenor and O. Buneman, Computer Physics Comm., 69, 1992.
2. P.C. Liewer and V.K. Decyk, J. Computational Physics, 85, 1989.